



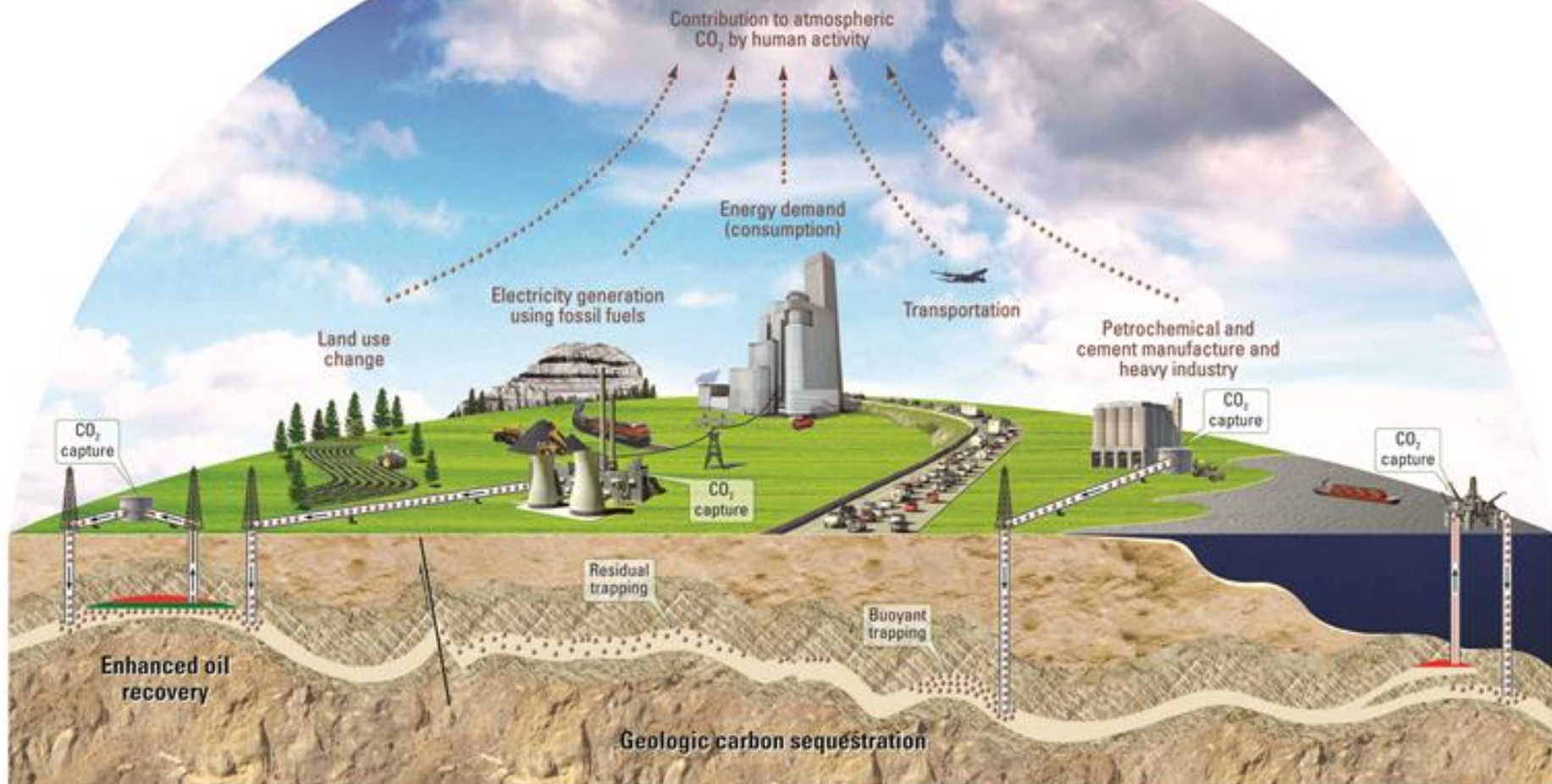
Using ArcGIS to Identify Environmental Risk Factors Associated with CO₂ Storage

Mayur A Gosai & Christopher P Garrity
USGS Energy Resources Program
12 July 2011

Energy Independence & Security Act 2007

1. The **geographical extent** of all potential sequestration formations in all states;
2. The capacity of the potential sequestration formations;
3. The injectivity of the potential sequestration formations;
4. An estimate of potential volumes of oil and gas recoverable by injection and sequestration of industrial carbon dioxide in potential sequestration formations;
5. The **risk associated** with the potential sequestration formations; and;
6. The work done to develop the Carbon Sequestration Atlas of the United States and Canada that was completed by the department.

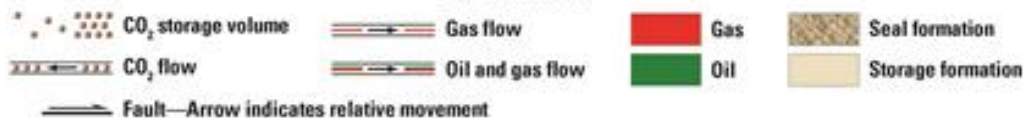
The Concept of Geologic Carbon Sequestration



NOT TO SCALE

Illustration by Douglas W. Duncan and Eric A. Morrissey

EXPLANATION



Assessment Open File Reports

Methodology

- OFR 2010-1127

Individual basins

- OFR 2011-xxx-A
- Series (OFRs)
- ~30

Final report

- Scientific Investigations Report
- Calculations

Digital data...



Geology of the U.S. Geological Survey Carbon Dioxide Storage Assessment—Bighorn Basin, Wyoming

*By Jacob A. Covault, Marc L. Buursink, William H. Craddock, Matthew Merrill, Madalyn S. Blondes, and
Mayur A. Gosai*

| Chapter A of
Geology of the U.S. Geological Survey Carbon Dioxide Storage Assessment
Edited by Peter D. Warwick and Margo D. Corum

Open-File Report 2011-XXXX-A

U.S. Department of the Interior
U.S. Geological Survey



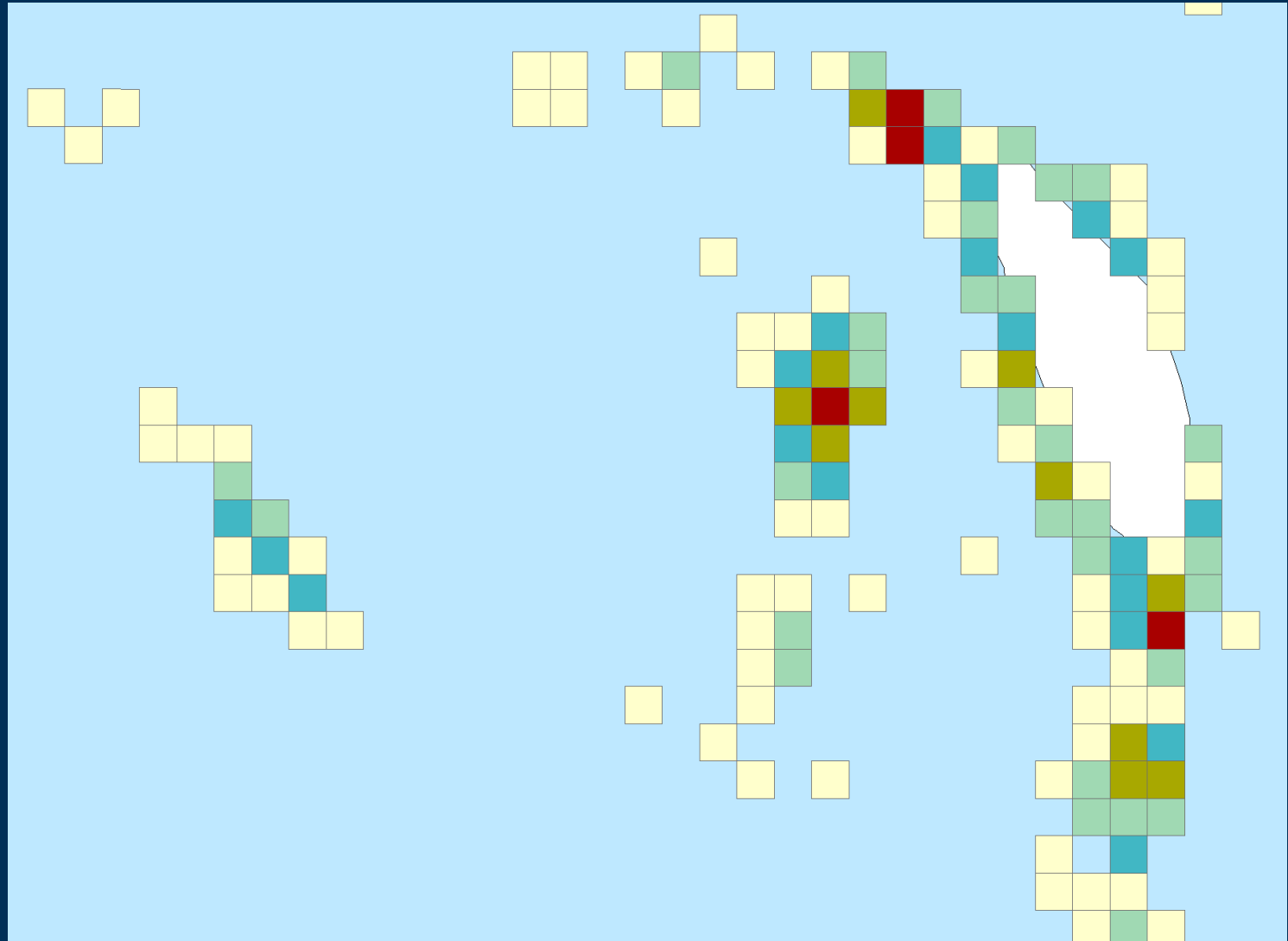
Well Density

(modeling purpose)

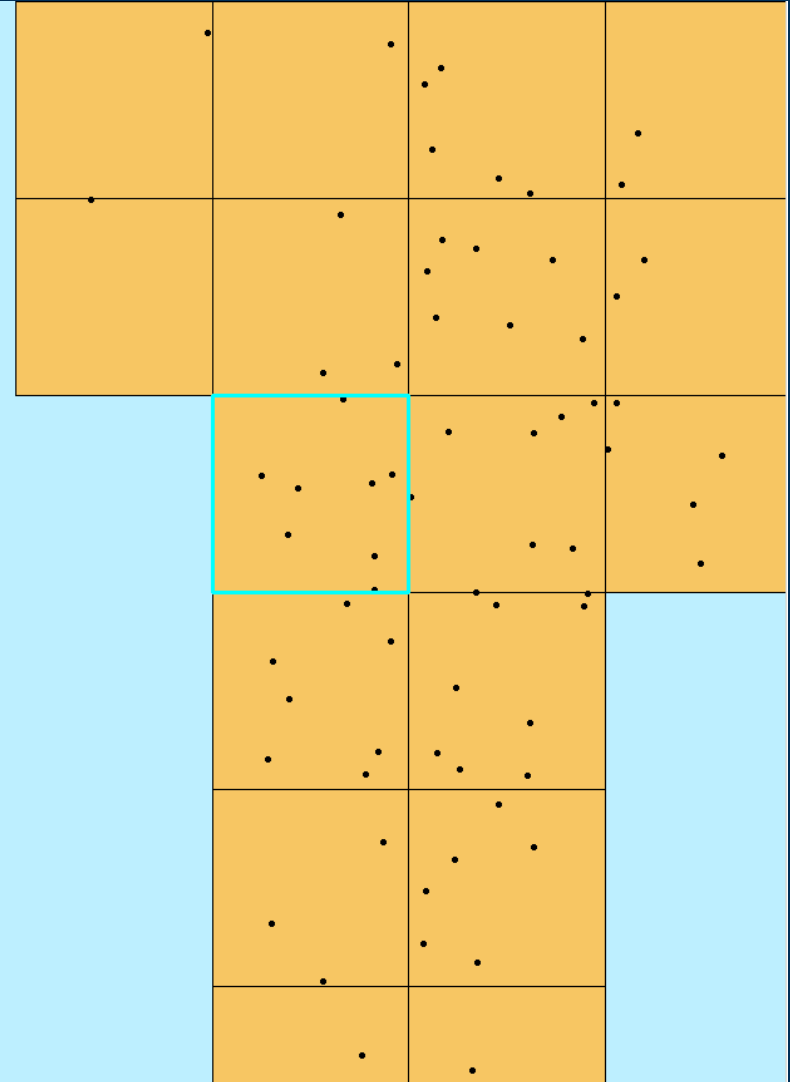
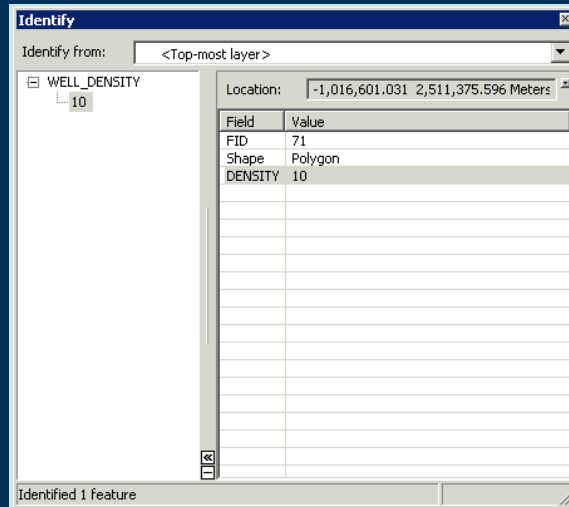
- Automation
- Location of wells
- Leakage risk
- Geologic risk



Well Density ¼ sq. mile aggregation



Well Density 1/4 sq. mile aggregation



IHS Energy Group



Information Handling Services (~1960)

- **Production & Exploration data**
- **Daily updates available**
- **Petroleum Information & Dwights (PIDwights)**
- **Proprietary data agreements**

Nationwide Well Database

- 32 states (subset)
- Eastern & central (some) US
- 899,090 wells
- Gulf Coast & western US not included...
- Large volume!



Well counts in IHS ENERGDEQ (Jan. 20-26, 2011)

State	Code	Well Count
Alabama	01	17,096
Arkansas	03	43,378
Connecticut	06	
Delaware	07	
District of Columbia	08	
Florida	09	1,382
Georgia	10	192
Illinois	12	142,248
Indiana	13	22,390
Iowa	14	212
Kentucky	16	128,595
Louisiana	17	284,798
Maine	18	
Maryland	19	253
Massachusetts	20	
Michigan	21	67,138
Minnesota	22	338
Mississippi	23	37,502
Missouri	24	2,227
New Hampshire	28	
New Jersey	29	4
New York	31	37,977
North Carolina	32	129
Ohio	34	218,265
Pennsylvania	37	185,114
Rhode Island	38	
South Carolina	39	36
Tennessee	41	15,080
Vermont	44	2
Virginia	45	10,054
West Virginia	47	136,245
Wisconsin	48	7
Atlantic Coast Offshore	61	55

Well Data Compilation

* Well information collected through research & literature investigation

Database codes:

- Known to bottom in the SAU formation (K)
- Assumed to penetrate through to older rocks (A)
- Unknown bottom but known driller's total depth (U)
- No total depth (null)

Well Density Model (ArcToolbox)

Generate Well Density Cell Map

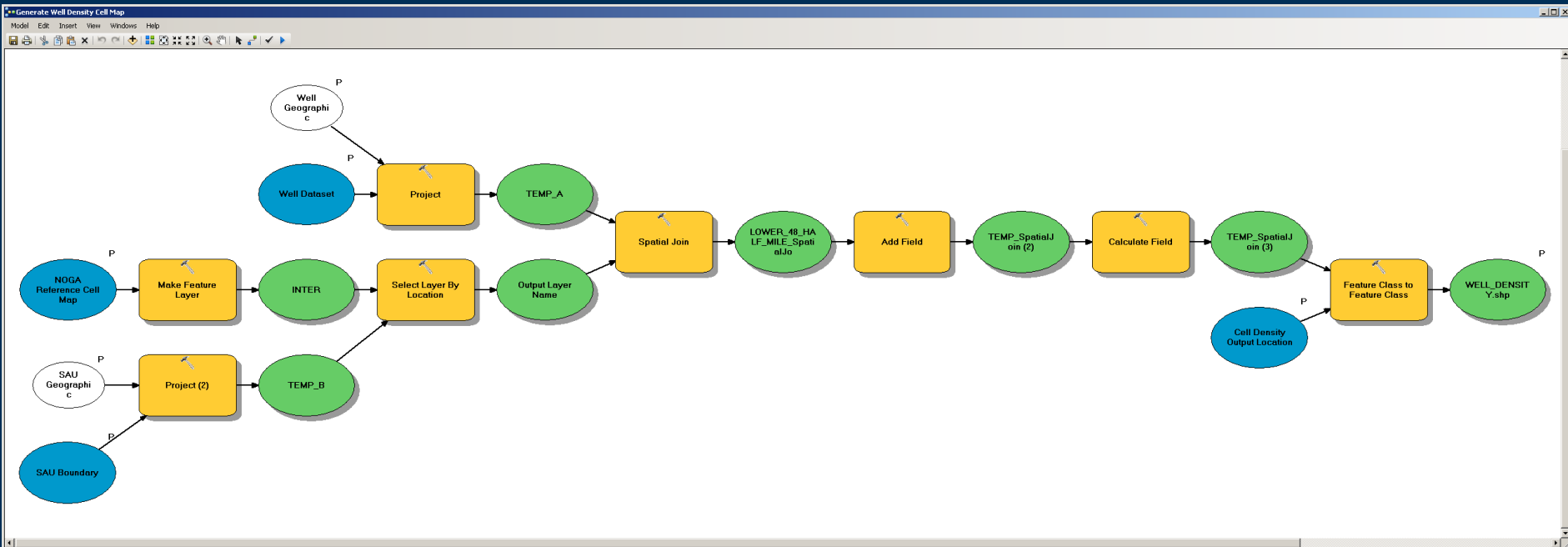
SAU Boundary
Well Dataset
Cell Density Output Location
C:\TEMP\Documents
Well Geographic Transformation Method (optional)
SAU Geographic Transformation Method (optional)
NOGA Reference Cell Map
C:\TEMP\REF_GRIDS\REF_GRIDS_NAD83.gdb\LOWER_48_HALF_MILE

Generate Well Density Cell Map

This prototype tool generates a cell density shapefile based on exsisting NOGA 1/2 mile grid. Output shapefile projection matches NOGA Albers NAD83 parameters. Choose NAD27 to NAD83 geographic transformation method for SAU and/or well feature class only when indicated by green dot. Otherwise leave blank.

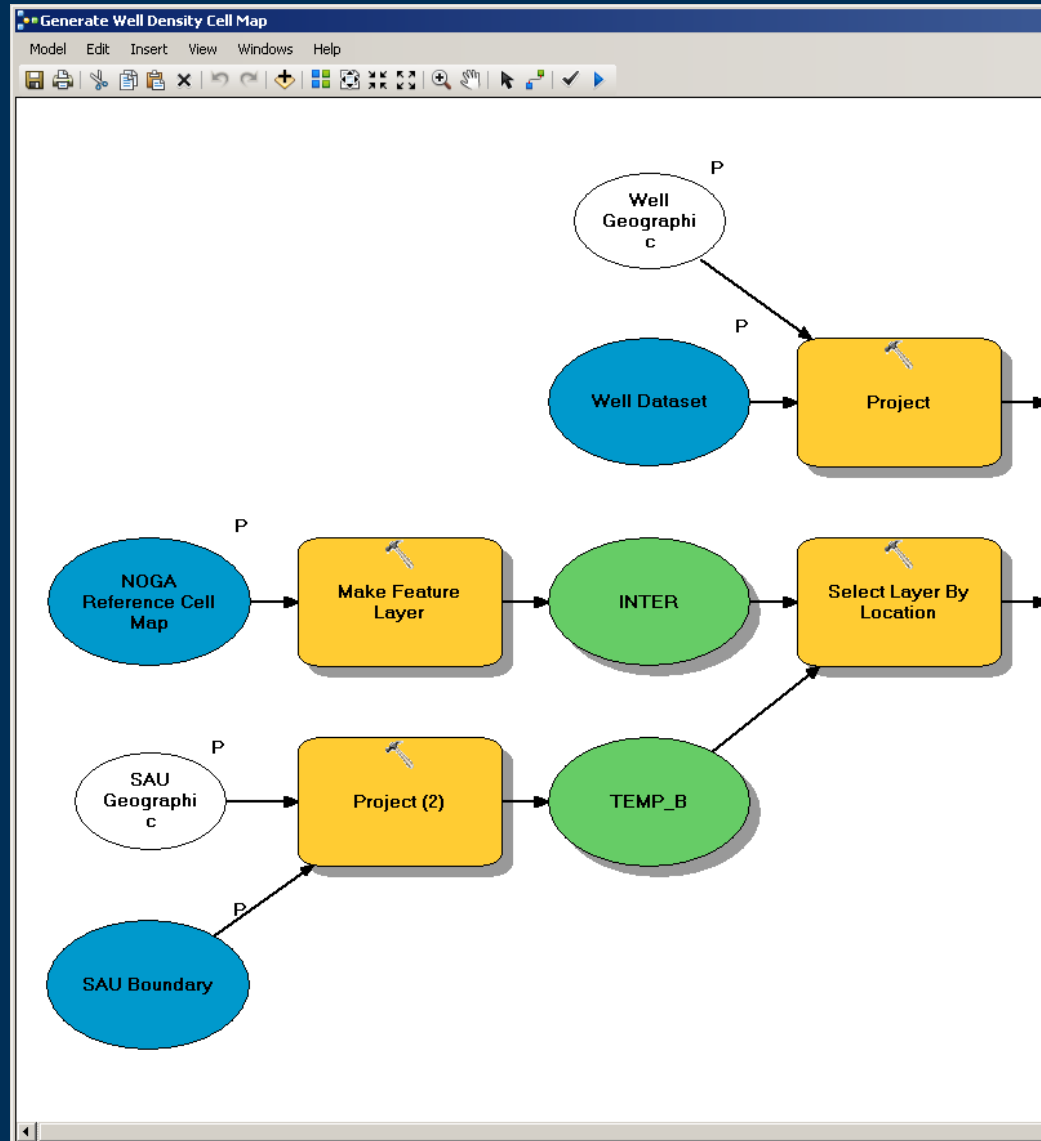
OK Cancel Environments... << Hide Help Tool Help

Well Density Model Workflow



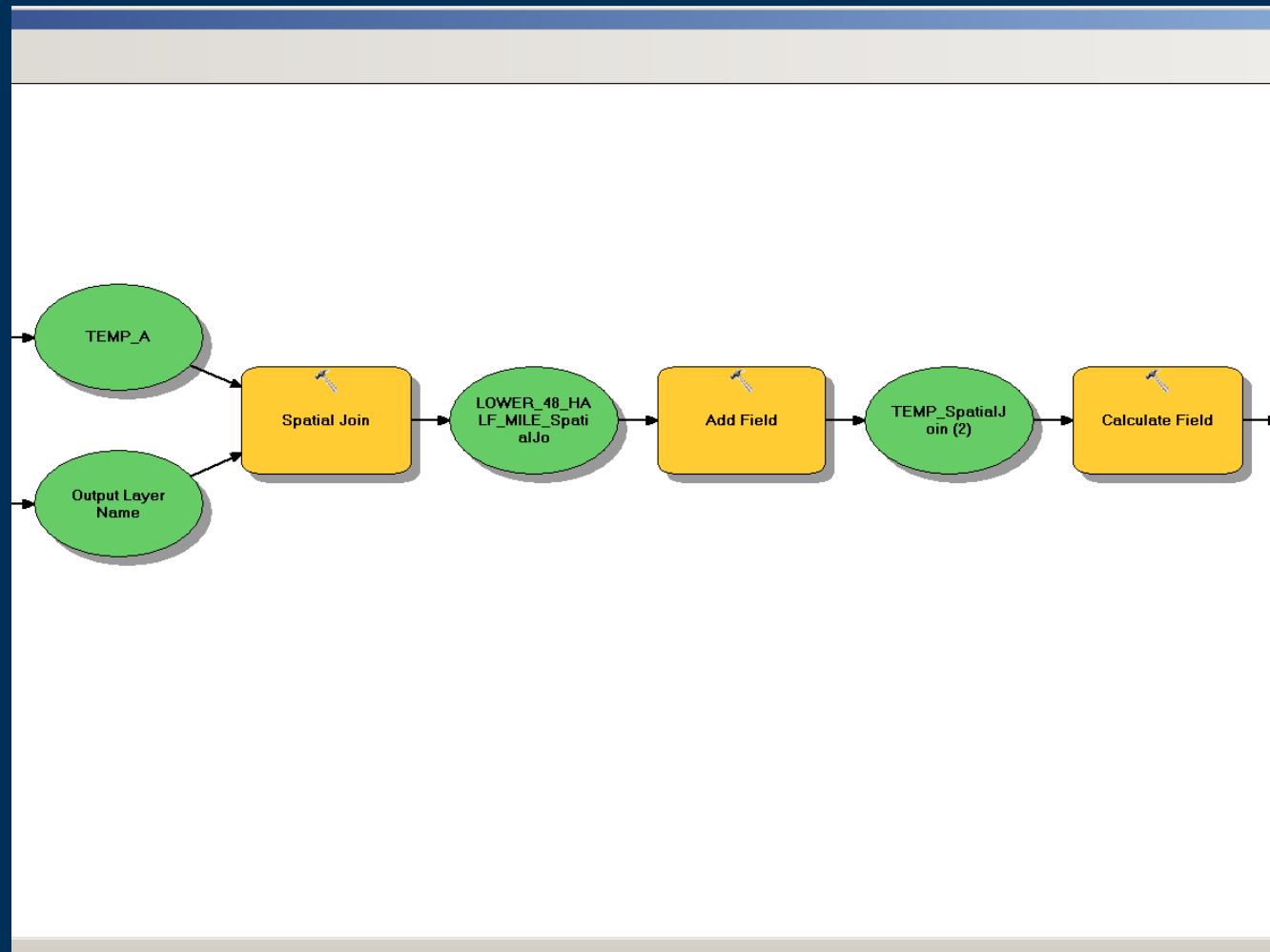
Well Density Model Workflow (part I)

- Grid cell created
- Well data projected
- SAU projected
- Cells that intersect SAU



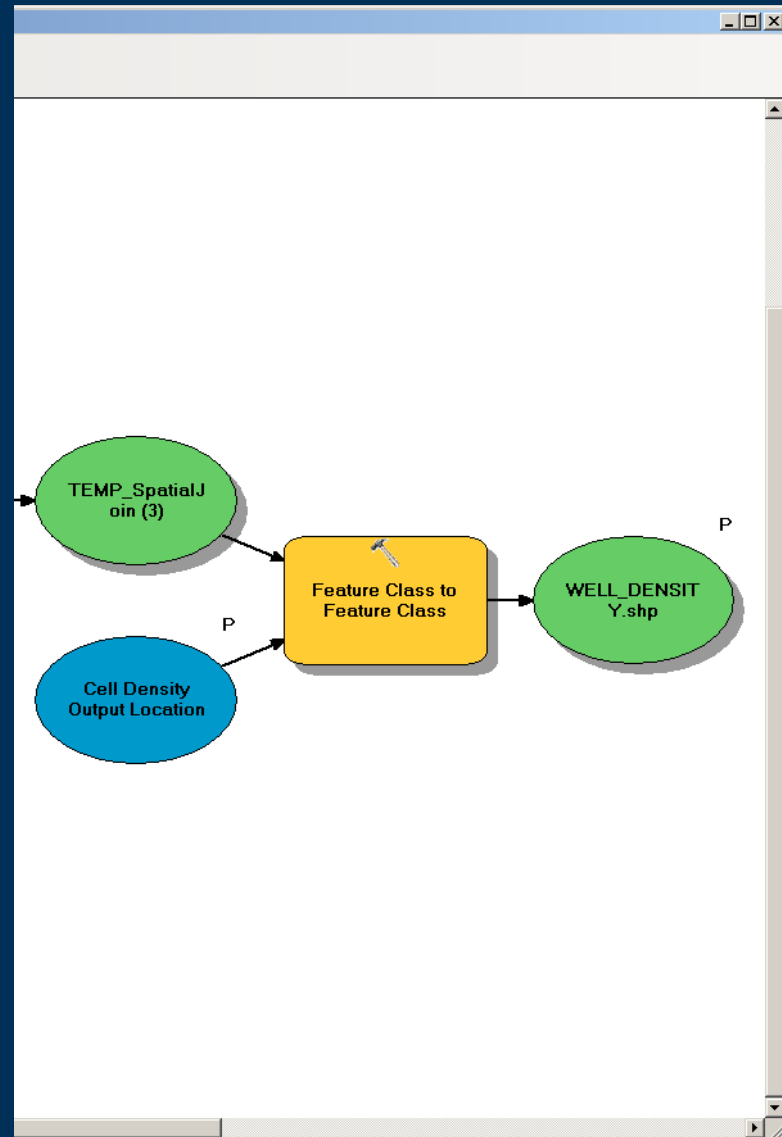
Well Density Model Workflow (part II)

- 1 to 1 join of well data and grid cells
- “Density” field added
- Count of wells that fall within the cell is calculated

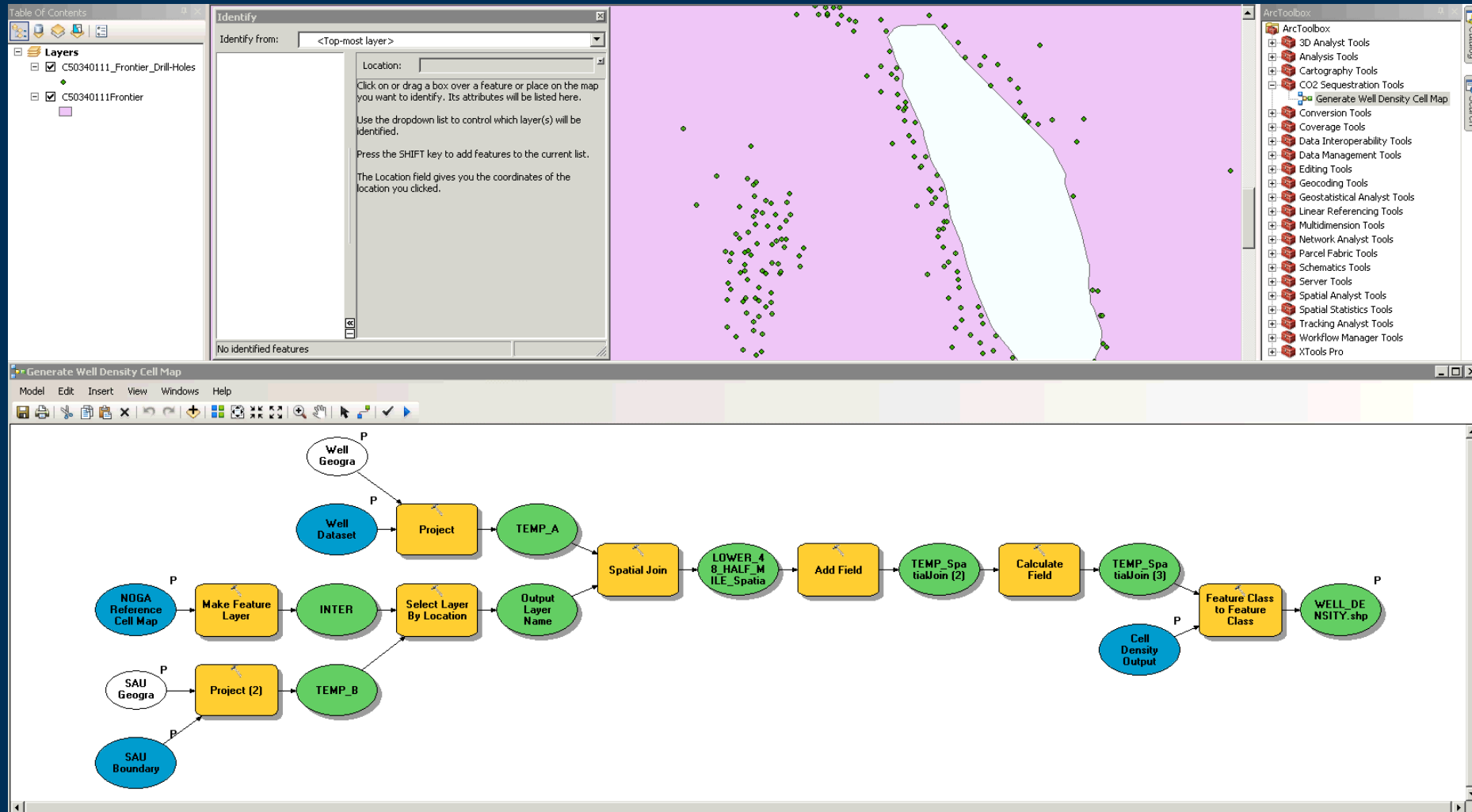


Well Density Model Workflow (part III)

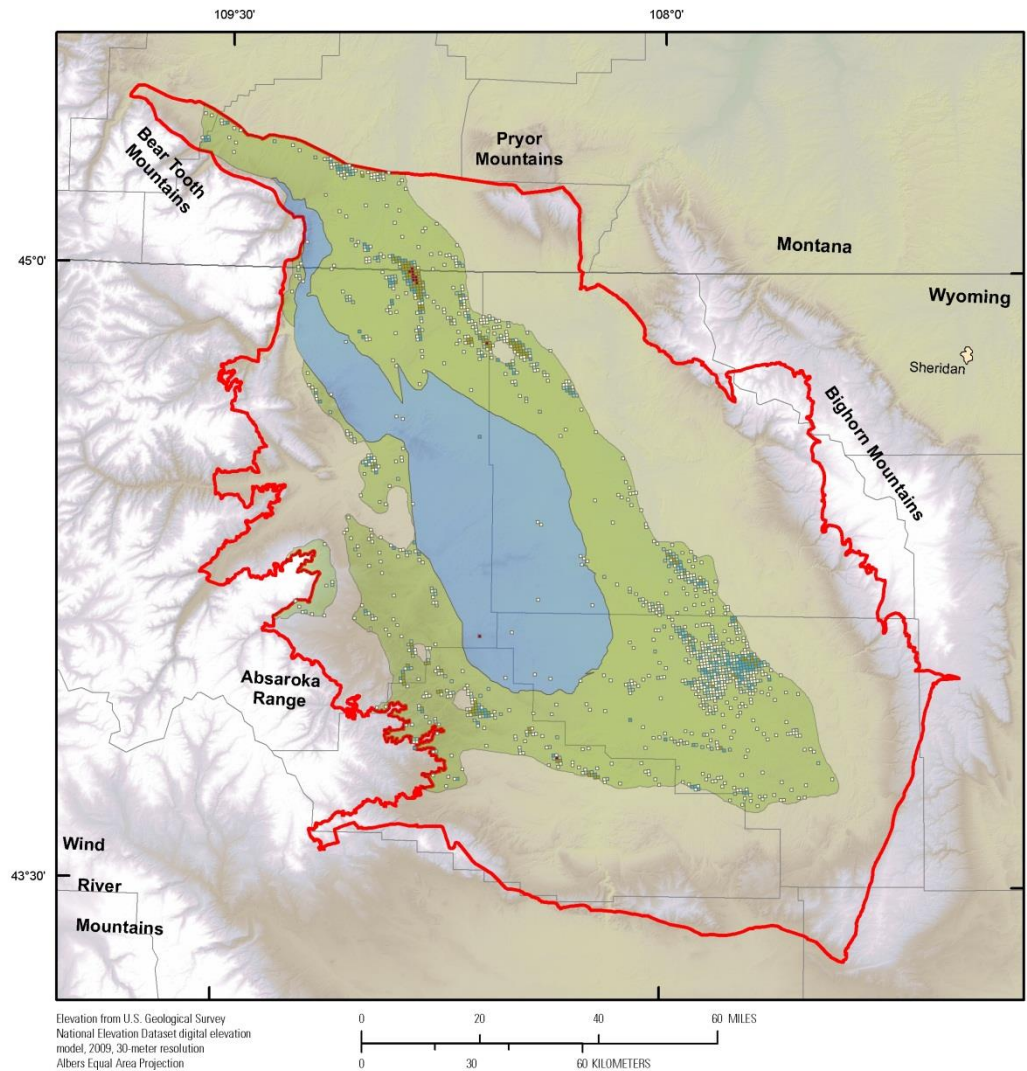
- Feature class is created of cell that have a density count >1
- Output location specified
- “WELL_DENSITY.shp” created



Well Density Model (AVI “run entire model mode”)



Cloverly Formation



Elevation from U.S. Geological Survey
National Elevation Dataset digital elevation
model, 2009, 30-meter resolution
Albers Equal Area Projection

EXPLANATION

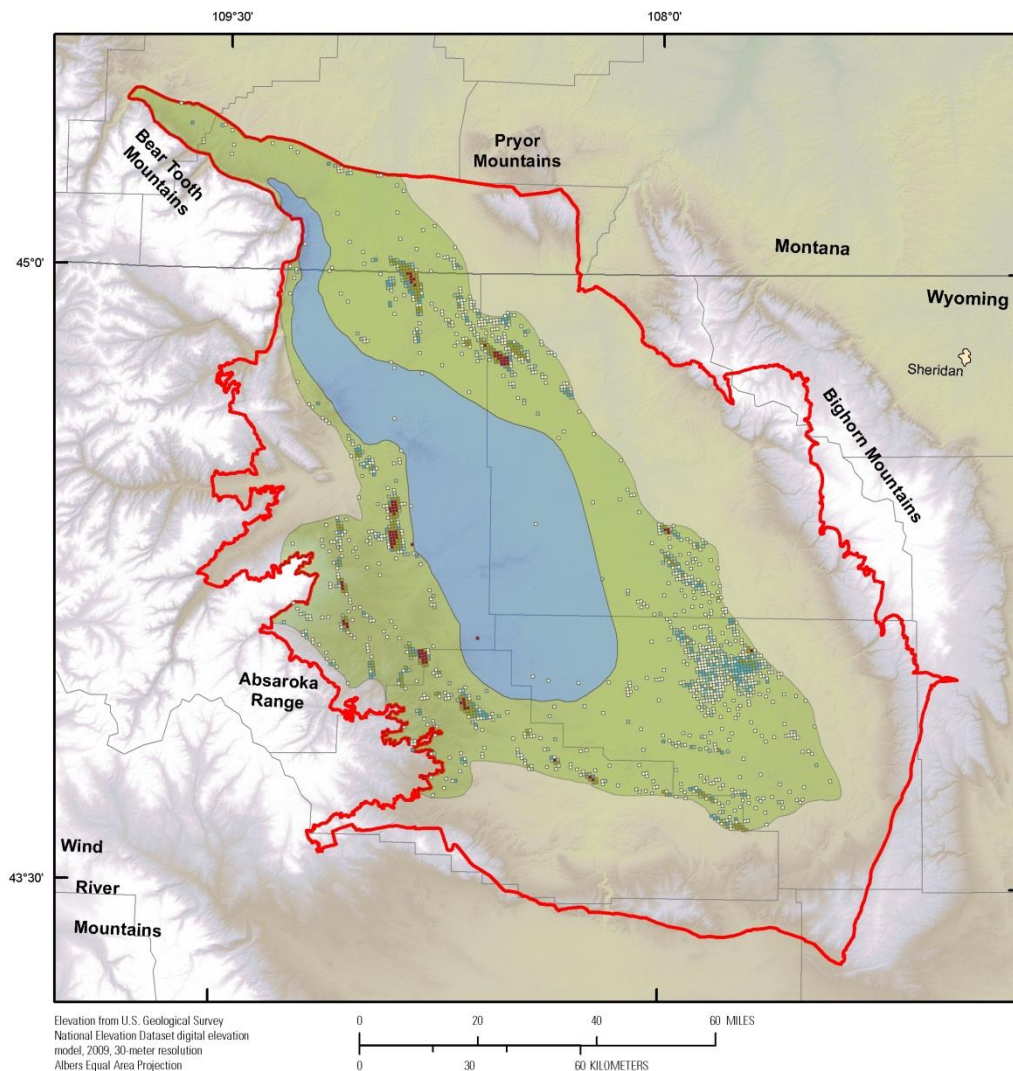
- C50340107 Cloverly
(3,000 to 13,000 ft below surface)
- C50340108 Cloverly Deep
(> 13,000 ft below surface)
- Bighorn Basin outline
modified from USGS National
Oil and Gas Assessment Bighorn
Basin Total Petroleum Systems boundary
U.S. Geological Survey
Bighorn Basin
Assessment Team, 2010

Well Penetration Density per 1/4 Square Mile

- 1
- 2
- 3 - 4
- 5 - 16
- 17 +



Crow Mountain Formation



Elevation from U.S. Geological Survey
National Elevation Dataset digital elevation
model, 2009, 30-meter resolution
Albers Equal Area Projection



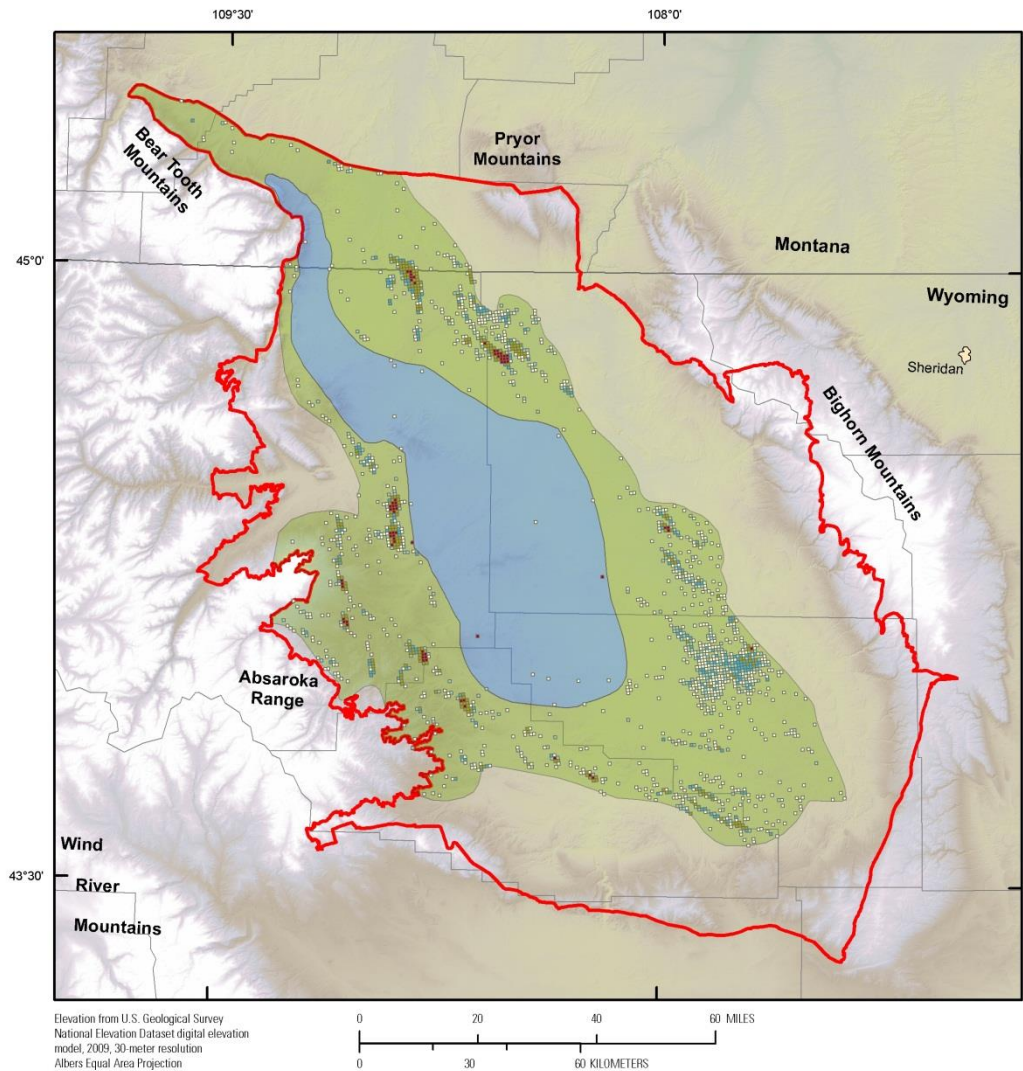
EXPLANATION

- C50340105 Crow Mountain
(3,000 to 13,000 ft below surface)
- C50340106 Crow Mountain Deep
(> 13,000 ft below surface)
- Bighorn Basin outline
modified from USGS National
Oil and Gas Assessment Bighorn
Basin Total Petroleum Systems boundary
U.S. Geological Survey
Bighorn Basin
Assessment Team, 2010

Well Penetration Density per 1/4 Square Mile

- 1
- 2
- 3 - 4
- 5 - 16
- 17 +

Ervay Formation



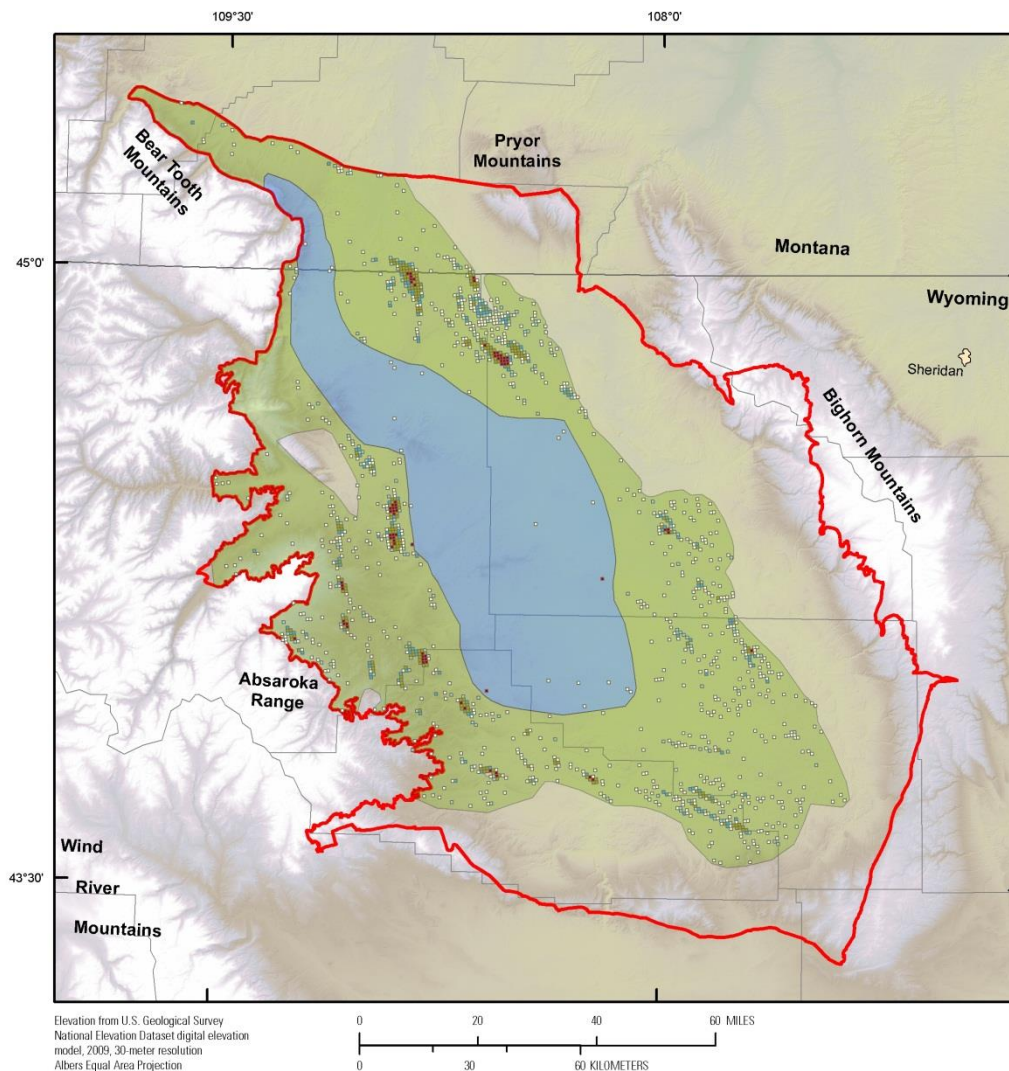
EXPLANATION

- C50340103 Ervay
(3,000 to 13,000 ft below surface)
- C50340104 Ervay Deep
(> 13,000 ft below surface)
- Bighorn Basin outline
modified from USGS National
Oil and Gas Assessment Bighorn
Basin Total Petroleum Systems boundary
U.S. Geological Survey
Bighorn Basin
Assessment Team, 2010

Well Penetration Density per 1/4 Square Mile

- 1
- 2
- 3 - 4
- 5 - 16
- 17 +

Tensleep Formation



EXPLANATION

- C50340101 Tensleep
(3,000 to 13,000 ft below surface)
- C50340102 Tensleep Deep
(> 13,000 ft below surface)
- Bighorn Basin outline
modified from USGS National
Oil and Gas Assessment Bighorn
Basin Total Petroleum Systems boundary
U.S. Geological Survey
Bighorn Basin
Assessment Team, 2010

Well Penetration Density per 1/4 Square Mile

- 1
- 2
- 3 - 4
- 5 - 16
- 17 +

Data Availability

- **Storage Assessment Units (SAUs)**
- **1/4 square mile well density (nationwide)**
- **Assessed sedimentary basins boundary**
 - **Total Petroleum Systems (TPS)**
 - **NOGA modified**

Web mapping deliverables

- ArcGIS API for Flex
- <http://energy.usgs.gov>
 - Health and Human...
 - Geologic CO2 Sequestration...
 - Data tab



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Energy Resources Program



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Geochemistry & Geophysics

General Info

Outer Continental Shelf Energy D
An Evaluation of the Science Needs to In
Outer Continental Shelf Energy Develop
and Beaufort Seas, Alaska.

► Ecosystems & Human Health

Acid Mine Drainage

Mercury & Selenium

Medical Geology

► Energy Production & Use

Geologic CO2 Sequestration

Produced Waters



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<http://energy.usgs.gov>

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